Momentary Assessment Research in Psychosis

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Abstract:

There is an expanding interest to study psychosis in the realm of daily life. The study of the person in the context of daily life may provide a powerful addition to more conventional and cross-sectional research strategies in the study of psychosis. This article first discusses the nature of experience sampling research in psychosis and demonstrates the feasibility and validity of studies using the experience sampling method (ESM) in this patient group. Second, the article presents a review of all ESM research in psychosis with a special focus on (a) the phenomenology, (b) the etiology, and (c) psychological models of psychosis. Variability over time and the dynamic interplay with the environment were found to be essential features of the positive symptoms of psychosis, whereas behavioral patterns as well as self-reported affect in daily life reality might be essential when studying negative symptomatology. ESM contributes to a better understanding of the interplay between psychotic experiences and environmental features, such as stress or cannabis exposure. Finally, the study of symptomatic variability may fuel new research into psychological models and treatment of psychosis and the study of the person–environment interplay may foster new Gene × Environment interaction studies.

Keywords: sychosis | schizophrenia | momentary assessment | daily life | phenomenology | experience sampling method | etiology | psychological models | psychology

Article:

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There is an expanding interest the study of psychotic disorders in the realm of daily life. Nonaffective psychotic disorders such as schizophrenia, delusional disorder, and schizoaffective disorder are characterized by a number of symptoms such as delusions and hallucinations but also flat affect, anhedonia, and asociality. The essence of these psychotic

experiences may be found in the interaction between the person and the environment, providing a powerful rationale for investigating experiences in the context in which they are occurring. Furthermore, there is a growing need in psychosis research to validate experimental and questionnaire findings in the realm of daily life, relating laboratory findings to real-life functioning (Koren, Seidman, Goldsmith, & Harvey, 2006). The study of persons in the context of normal daily life may thus provide a powerful addition to more conventional and cross-sectional research strategies in the study of psychotic disorders. However, the first and most pertinent question is whether research on the daily life of patients who have a diagnosis of severe mental illness is feasible.

Two early studies demonstrated the feasibility of momentary assessment studies and can be considered the starting point of daily life research in psychosis. The first study was a 2-week single-case study of a 23-year-old woman with a diagnosis of schizophrenia (Hurlburt & Melancon, 1987). The participant was signaled approximately 10 times a day at random times through a small earphone. At the moment of the signal, she was asked to freeze and write down a description of her ongoing inner experience. Each day, she discussed the described experiences in detail with the researchers. The patient predominantly reported visual experiences, and the majority of her everyday inner visual experiences were distorted. Most descriptions of these experiences were concrete representations of the external situation with some minor details slightly modified or tilted in some way. These visual images were recognized as being distorted by the patient and did not surprise her, suggesting that the distorted images were common to the patient and might influence her daily life and behavior to a large extent (Hurlburt & Melancon, 1987). The second study investigated a sample of 11 patients with severe mental illness (5 of whom had a diagnosis of a psychosis spectrum disorder) and 11 control participants. The goal of this study was to map participants' daily lives, describe their self-reported mental states, and investigate how changes in their social environment impacted mental state. Patients reported psychopathology in 28% of all the reports and showed subtle differences compared with control subjects. For example, patients reported more often "doing nothing" and demonstrated greater reactivity to environmental influences (Delespaul & deVries, 1987). These studies were the first to demonstrate that psychotic patients are able to report meaningfully about their inner experiences and their behavior in the flow of daily life.

Since these early studies, interest in research with a specific focus on the experience of psychosis in the realm of daily life has increased dramatically. This article first provides an overview of the nature and methodology of momentary assessment studies in psychosis. Then, a review is presented of all momentary assessment research that has been conducted in the field of nonaffective psychotic disorders.

Experience Sampling Method (ESM)

ESM—or, as it is also known, ecological momentary assessment—is a momentary assessment strategy that can be used to study psychotic experiences in daily life. The nature and specific characteristics of ESM in general have been explained in the other articles in this special issue. We focus on the specific issues related to ESM research in psychosis.

Validity and Reliability

A major issue in ESM research is whether patients with a severe mental disorder like a psychotic disorder are able to provide reliable and valid self-reports regarding their current cognitions, affect, behavior, and environmental context. This issue is not solely related to psychosis research but certainly needs special attention in ESM studies on psychosis.

Because psychotic experiences are frequently internal phenomena, we have to rely on self-report and introspection to gain information (Stone et al., 2000). Clinical interviews and questionnaire measures are based on these methods, but their (mostly retrospective) structure makes them susceptible to biases. The prospective and real-time assessments of mood and psychopathology make ESM studies less vulnerable to these recall biases. This might be particularly important in the study of psychosis, because it has been consistently shown that patients with psychotic disorders have decreased cognitive capacities (Krabbendam, Arts, van Os, & Aleman, 2005; Reichenberg & Harvey, 2007), which may even increase their proneness to bias. Some authors have argued that the capacity for self-report is diminished in patients with psychosis because they lack insight (Debowska, Grazywa, & Kucharska-Pietura, 1998). ESM studies, however, have found meaningful variation in a number of domains such as mood and symptoms.

Investigating or measuring the validity and reliability of ESM data is difficult because of the subjective nature of the reports. The assessment of validity is complicated by the fact that experiences assessed using ESM, such as “I feel lonely,” may not necessarily have behavioral expressions, which makes them difficult to verify (Kimhy et al., 2006). The subjective nature of reports, however, is central to the concept of psychopathology and there are no uniform objective (external) correlates that are valid measures of psychopathology.

Investigating the reliability of ESM data, defined as the reproducibility and consistency of the obtained data, is also complicated. ESM items measure characteristics that are expected to fluctuate across repeated measures. Good ESM items should thus be relatively temporally unstable and show considerable fluctuation throughout the day. This might be particularly true for psychopathology items, because it has been argued that increased variation of mood and symptoms is a central characteristic of severe mental illness. Therefore, the direct application of traditional methods of examining reliability, such as internal consistency and test–retest reliability, is problematic. Delespaul (1995) suggested that a multiple indicator approach might be applied to assess the reliability of subjective and dynamic constructs such as psychotic or negative mood states. A specific state might then be assessed using several ESM items that show good internal consistency.

Feasibility and Compliance

It could be argued that the complexity of the ESM may result in a selection bias, with only better performing patients being able to participate in ESM studies. However, ESM has been conducted with a wide variety of patients with psychotic disorders, including individuals with acute paranoia (Myin-Germeys, Nicolson, & Delespaul, 2001; Thewissen, Bentall, Lecomte, van Os, & Myin-Germeys, 2008) and people who use cannabis heavily (Henquet, Rosa, et al., 2009), as well as high-risk subjects and patients with psychosis in remission (Husky, Grondin, & Swendsen, 2004; Myin-Germeys, van Os, Schwartz, Stone, & Delespaul, 2001). Overall, all research samples showed acceptable numbers of valid reports (reports completed within 15 min of the beep; Delespaul, 1995). Populations with a higher degree of illness showed a higher drop-out rate, with patients dropping out of the study before the end of the 6 days. However, acceptable numbers can be achieved (Thewissen et al., 2008).

Compliance with the research protocol is another important issue in momentary assessment research. Compliance in these studies involves several aspects, such as completing an adequate number of assessments, completing the assessments at the time signaled, and accurately completing the protocols. Participants' compliance is not guaranteed because the study is conducted during the course of everyday life, without the researcher being present. Compliance in patients with psychosis was specifically investigated in one Palm study.Almost 90% of participants with schizophrenia completed an average of over two thirds of the electronic questionnaires. This compliance rate was only somewhat lower than those in previous studies using computerized ESM in nonpsychiatric (90–96%) and higher functioning psychiatric samples (86–92%; Granholm, Loh, & Swendsen, 2008). These rates indicate that people with schizophrenia are willing and able to participate in ESM studies. Compliance can further be enhanced by careful design and implementation.

ESM Studies in Psychosis

We now review all studies using ESM to study nonaffective psychotic disorders and psychotic symptoms with a special focus on the (a) phenomenology, (b) etiology, and (c) psychological models of psychosis. The database PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) was screened for published studies using the keywords *experience sampling method**, *momentary assessment**, and *ecological momentary assessment** in combination with *psychosis, schizoph**, and *psychoti**. Abstracts were screened and articles were selected that used the actual ecological momentary assessment or the ESM to study psychosis. In addition, a first and last author bibliographical search was conducted for all articles resulting from the first search. Finally, a number of general ESM review articles were screened for articles on ESM and psychosis (Moskowitz & Young, 2006; Shiffman, Stone, & Hufford, 2008).

Phenomenology

ESM is a powerful tool to study the phenomenology of psychotic symptomatology in the flow of daily life. When are psychotic symptoms present? Do they fluctuate over time? How do psychotic symptoms impact daily functioning? What contextual conditions trigger, accompany, or follow symptoms in the flow of daily life? Knowledge about the context of psychotic symptoms allows for a better understanding of the phenomenology of symptoms and their underlying mechanisms and might therefore provide new strategies to diminish the impact of symptoms in the daily life of patients. Furthermore, ESM could also be a useful tool in clinical practice, as it provides the therapist with context-related specific information on the occurrence of symptoms and functioning patients in their actual daily lives (Delespaul, deVries, & van Os, 2002; Myin-Germeys, Nicolson, & Delespaul, 2001).
Symptomatology in psychosis spectrum disorders is heterogeneous. Factor analytic studies suggest the existence of at least three symptom dimensions: a positive symptom dimension, a negative symptom dimension, and a disorganized dimension (Andreasen, 1982; Liddle, 1987; Peralta, de Leon, & Cuesta, 1992). The positive symptom dimension reflects an excess or distortion of normal functioning and includes delusions and hallucinations. The negative symptom dimension is characterized by the absence or diminution of normal behaviors and functions and consists of symptoms such as flat affect, anhedonia, and social withdrawal. The disorganized dimension consists of symptoms such as positive formal thought disorder,

inappropriate affect, and bizarre behavior. Momentary research strategies have been used to study positive and negative symptoms.

Positive symptoms

Several ESM studies investigated the phenomenology of positive symptoms of psychosis in daily life. Because not all psychotic symptoms are recognized as such by patients with a psychotic disorder, studying the symptoms by using self-reports must be accomplished indirectly. Although patients can, for example, distinguish between real voices and verbal hallucinations (Delespaul, 1995; deVries & Delespaul, 1989; Romme, Honig, Noorthoorn, & Escher, 1992), poor insight into delusions (Debowska et al., 1998) makes it very difficult for patients to report their presence or absence at specific moments in time. Self-report instruments for evaluating delusional thoughts such as the Personal Questionnaire (Brett-Jones, Garety, & Hemsley, 1987; Chadwick & Lowe, 1990) do exist but are not appropriate for repeated administration during daily activities in a large sample because they are time consuming, interfere with daily activities too much, and might even induce experiences. Therefore, items that assess aspects of mental states that people are aware of and that are directly associated with delusions in schizophrenia (Junginger, Barker, & Coe, 1992) or with psychosis in general need to be included. Items such as *preoccupation* ("I'm preoccupied by my thoughts right now"), *suspicion* ("My thoughts are suspicious"), *feeling unreal*, or *feeling controlled* ("My thoughts are being influenced") fulfill these criteria.

A recent study investigated hallucinations in daily life in patients with a diagnosis of psychotic disorder (Delespaul et al., 2002). The items "I hear voices" and "I see phenomena" (scored on a 7-point Likert-type scale) were used to assess visual and auditory hallucinations. Visual hallucinations were reported more frequently than auditory hallucinations, although auditory hallucinations were experienced with a higher intensity. This finding was contrary to what was expected, and the authors suggested that this might indicate that the predominance of auditory hallucinations in subjects with schizophrenia is a methodological artifact in studies using traditional retrospective methods. Furthermore, context was found to influence the course of a hallucinatory episode to a great extent. Withdrawing socially, engaging in work activities, and doing nothing were associated with decreased hallucinatory intensity, whereas being in the company of other persons or engaging in passive leisure activities were associated with slightly increased hallucinatory intensity.Therefore, the authors concluded that both maximal engagement (work activities) and maximal disengagement (withdrawal from people and activities) might be coping mechanisms for hallucinations (Delespaul et al., 2002).

Myin-Germeys, Nicolson, and Delespaul (2001) investigated the phenomenology of delusions in 48 patients with chronic schizophrenia. The majority of patients reported delusional moments in daily life. However, the intensity of these delusional experiences changed over periods of hours. Furthermore, environmental factors were found to influence these moment-to-moment variations. Patients were less likely to be delusional in the presence of acquaintances and family members and at increased risk of experiencing a delusional moment when they changed from involvement in an activity to doing nothing. The authors concluded that withdrawal from activities and being alone are risk factors for delusional relapse in daily life (Myin-Germeys, Nicolson, & Delespaul, 2001).

The expression of (subclinical) psychotic experiences and its contextual determinants have also been investigated using ESM in a nonclinical population of university students (Verdoux, Husky,

Tournier, Sorbara, & Swendsen, 2003). Psychotic experiences were defined as *perceived hostility* ("How would you describe the social ambiance and the persons you met?"), *strange impressions* ("Did you have the impression that something strange happened to you or around you that you could not explain?"), *unusual perceptions* ("Did you have unusual perceptual experiences?"), and *thought influence* ("Did you have the impression that your thoughts or emotions could be read or influenced?"). The effects of social company on the occurrence of psychotic experiences in daily life were found to be dependent on the participants' level of vulnerability for psychosis. In participants with a low vulnerability for psychosis, social company did not influence the occurrence of psychotic experiences. Yet, participants with higher psychosis vulnerability experienced more unusual perceptions in the presence of unfamiliar individuals as compared with when alone and reported more strange impressions when with family members or friends than when alone. It is interesting that change in social company was found to be a stronger predictor of occurrence of psychotic experiences than social company per se (Verdoux, Husky, et al., 2003).

Negative symptoms

Negative symptoms have also been studied using ESM. As with the positive symptoms, asking subjects to self-report their negative symptoms might not reveal valid reports. Negative symptoms need to be defined in terms of mood and behavior as they occur in daily life. This obviously means that negative symptoms defined solely on clinical observation, such as alogia, are not suited to study with ESM.

The first ESM study on negative symptoms in patients with a psychotic disorder studied emotional experience with ESM and flat affect using an observational interview. Flattened emotional experience was defined as a decrease in both the intensity and the variability of emotions over time. In this study, on a sample of 58 patients with schizophrenia and 65 control subjects, more intense and more variable negative emotions were found in patients compared with controls (Myin-Germeys, Delespaul, & deVries, 2000). The intensity and variability of positive emotions, however, were decreased in patients compared with controls, suggestive of either a decreased hedonic capacity or a less positive daily life evoking less pleasant emotions. Furthermore, schizophrenia patients who had interview-rated flattened affect did not differ from patients without flattened affect on emotional experience measured using ESM. These results are in line with laboratory studies suggesting that schizophrenia patients have no deficits in the internal experience of emotions but rather show deficits in outward emotional expression (Cohen & Minor, 2008; Myin-Germeys et al., 2000). Another study focused further on the inability to experience pleasure, referred to as*anhedonia*. Patients are found to report lower levels of pleasure than do controls on self-report trait measures and in semistructured interviews but report as many pleasant emotions as do controls in response to emotionally evocative stimuli (Horan, Kring, & Blanchard, 2006). Therefore, one ESM study investigated both consummatory pleasure (defined as the level of pleasure when directly engaged in an enjoyable activity) and anticipatory pleasure (defined as the experience of pleasure related to future activities). Patients reported similar consummatory pleasure levels as controls but reported less anticipatory pleasure from future goal-directed activities. Furthermore, they were less often engaged in goal-directed activities than were controls. These results suggest that anhedonia might be defined as a deficit in anticipatory pleasure rather than in consummatory pleasure (Gard, Kring, Gard, Horan, & Green, 2007).

Negative symptoms can also be defined in terms of behavioral outcome and patterns in daily life. Husky and colleagues, for example, studied psychosis proneness in the general population and found psychosis-prone subjects were not more socially withdrawn than non-psychosis-prone individuals (Husky et al., 2004). However, psychosis-prone subjects were more often doing nothing, suggesting that they have more difficulties related to their involvement in activities. In addition, psychosis proneness was found to predict anxiety and depression in specific environmental or social situations (Husky et al., 2004). For example, psychosis proneness predicted a decrease in depression and anxiety scores in situations where the individual was not likely to be confronted by social contact with people he or she did not know well.
Another study focused on the behavioral correlates and affective experiences of social anhedonia in a large nonclinical sample of 245 psychology students (Brown, Silvia, Myin-Germeys, & Kwapil, 2007). Participants scoring high on social anhedonia were found to spend more time alone, had a greater preference for being alone, and experienced less positive affect during social interactions compared with participants scoring low on social anhedonia. Social disinterest and withdrawal in social anhedonia appeared to be associated with decreased positive affect (e.g., social interactions were not rewarding), whereas decreased social contact related to social anxiety was driven by heightened negative affect.The expression of social anhedonia in daily life of a nonclinical population seems to be consistent with the observed behavior of schizophrenia patients.

Conclusion

The studies on the phenomenology of positive psychotic symptoms illustrate that both delusions and hallucinations show meaningful and widespread variation over time, with changes in presence and intensity over periods of moments and hours. The variation over time is to an important extent driven by situational characteristics. A better understanding of this variation and its determinants seems of crucial importance for the diagnosis as well as treatment of these symptoms. The ESM data on negative symptoms show that the study of behavioral patterns as well as of self-reported emotions may be an important addition to cross-sectional and observational data.

Etiology

Momentary assessment strategies may also constitute a powerful tool in examining underlying mechanisms relating to the onset and maintenance of psychosis, especially when these mechanisms involve changes with regard to how persons react to or behave in certain situations or environments.

Stress

Stress has been postulated to play an important role in psychosis. Vulnerability-stress models posit that psychotic symptoms emerge whenever cumulative stressors exceed the individual’s vulnerability threshold (Zubin & Spring, 1977; Zuckerman, 1999). Norman and Malla (1994) provided preliminary evidence for an association between daily hassles and symptom severity. They found significant correlations between symptom levels and the occurrence of daily hassles in the previous month. ESM is a useful tool to study daily hassles and even smaller

disturbances (e.g., doing an activity that one is not skilled at or motivated for or being in company that one does not like) that happen in the context of daily life, as well as the emotional and symptomatic reactions to these events, thus providing information on the stress–person interplay.

A number of studies have examined emotional reactivity to stress in daily life in psychosis. The first ESM study on emotional reactivity to stress investigated 42 patients with a diagnosis of a psychotic disorder in remission, 47 of their relatives, and 49 healthy control subjects (Myin-Germeys, van Os, et al., 2001). Results showed that higher levels of familial risk for psychosis were associated with higher levels of emotional reactivity to daily life stress, defined as both an increase in negative affect and a decrease in positive affect (Myin-Germeys, van Os, et al., 2001). Recently, Lataster et al. (2009) extended this finding to twins at increased psychometric risk for psychosis (scoring high on a schizotypy measure).Furthermore, this study showed a familial association between stress reactivity and subclinical psychosis. Increased stress reactivity in the proband twin was associated with subclinical psychotic experiences in the cotwin (Lataster et al., 2009). Another study investigated whether increased stress reactivity was specific to psychosis by comparing a sample of patients with psychosis with a sample of patients diagnosed with bipolar disorder and major depressive disorder (Myin-Germeys, Peeters, et al., 2003). Results of this study showed that stress sensitivity was present in all investigated groups and might therefore be a shared vulnerability of affective disorders and psychotic disorders. Patients with psychosis, however, seemed to be most vulnerable to the effect of daily stress because they reported the highest reactivity in both positive and negative affect.

Current models of the etiology and development of psychosis suggest that there are endophenotypes, or phenotypic expressions such as neurocognitive impairment that are intermediate between the genotype and the clinical expression of schizophrenia (e.g., Gottesman & Gould, 2003). The above-listed findings support the notion that stress reactivity is another possible endophenotype for psychosis. Therefore, studies have examined the relation of these two putative endophenotypes. Contrary to what was expected, altered stress sensitivity was either unrelated or inversely related to neurocognitive deficits (i.e., better cognitive performance was associated with increased emotional reactions to stress).Two studies in independent samples have supported this finding (Morrens et al., 2007; Myin-Germeys, Krabbendam, Delespaul, & van Os, 2003a). It seems, then, that stress sensitivity may be an independent affective pathway to psychosis, possibly underlying the positive symptoms of psychosis (Myin-Germeys & van Os, 2007).

These pathways appear to map onto positive and negative symptoms of schizophrenia. Stress in daily life has indeed been reported to induce variation in intensity of positive symptom experiences, in both patients and first-degree relatives (Myin-Germeys, Delespaul, & van Os, 2005). Furthermore, increased stress sensitivity has been associated with increased levels of positive symptoms and decreased levels of negative symptoms in patients with psychosis (Lataster et al., 2009). Negative symptoms, on the other hand, appear to be more strongly associated with neurological and neuropsychological deficits.

It was hypothesized that this affective pathway to psychosis may partially result from a sensitization process through which previous exposures to stress may sensitize people to the small stresses in daily life (Collip, Myin-Germeys, & Van Os, 2008). Indeed, previous exposures to life events (Myin-Germeys, Krabbendam, Delespaul, & Van Os, 2003b) and childhood trauma (Glaser, van Os, Portegijs, & Myin-Germeys, 2006; Wichers et al., 2009) increased the emotional reactivity to the small stresses in daily life, although the latter has so far

only been reported in the general population. It is interesting that the impact of life events on stress sensitivity was found to be modified by the degree of cognitive impairment. Only patients with good cognitive capacities were susceptible to the sensitization process induced by previous life events (Myin-Germeys, Krabbendam, et al., 2003a).Additional evidence for this affective pathway underlying the positive symptoms of psychosis comes from data showing that female patients report more stress sensitivity compared with male patients (Myin-Germeys, Krabbendam, Delespaul, & van Os, 2004). This fits with the clinical picture of female patients presenting higher levels of positive and affective symptoms as compared with male patients (Myin-Germeys et al., 2004).

ESM was also used to examine biological bases of the sensitization hypothesis. Myin-Germeys, Marcelis, Krabbendam, Delespaul, and van Os (2005) investigated dopamine release using the dopamine metabolite homovanillic acid (HVA) in plasma, induced by a physical stressor in a laboratory setting. They demonstrated that increased HVA levels in reaction to the physical stressor were associated with psychotic reactivity to daily life stress in first-degree relatives of patients with psychosis (Myin-Germeys, Marcelis, et al., 2005). Another study examined the association between emotional reactivity to stress in patients with psychosis and total volumes of cerebrospinal fluid (CSF), grey matter, and white matter (Marcelis et al., 2003). Total CSF volume was found to be positively associated with stress reactivity, whereas total white matter was negatively associated with emotional reactivity to stress and grey matter volume was not found to be associated with stress reactivity (Marcelis et al., 2003).

Cannabis use

Recent evidence suggest that cannabis use is associated with the onset, exacerbation, and recurrence of psychosis (Henquet, Di Forti, Morrison, Kuepper, & Murray, 2008; Murray, Morrison, Henquet, & Di Forti, 2007). However, an important difficulty is differentiating whether cannabis use results in psychotic symptoms or rather results from these symptoms.The longitudinal character of ESM was used to provide more insight into these issues. Verdoux, Gindre, Sorbara, Tournier, and Swendsen (2003) investigated the association between cannabis use and psychotic experiences and the impact of psychosis vulnerability on this relationship in a general population sample using ESM. Psychotic experiences were explored using several questions (rated on a 7-point Likert-type scale), such as “How would you describe the social ambiance and the persons you met?” and “Did you have the impression that your thoughts or emotions could be read or influenced?” Cannabis use was found to be associated with increased intensity of psychotic experiences. The effect of cannabis use was strongest in the participants with high vulnerability for psychosis and restricted to the 3 hours surrounding the cannabis use. It is interesting to note that participants with high vulnerability for psychosis benefited less from certain desirable effects of cannabis such as the enhanced positive feelings that can be associated with cannabis use (Verdoux, Gindre, et al., 2003). These results slightly differed from those of an ESM study on cannabis use and psychosis in a patient sample. Henquet and colleagues showed that patients with psychosis were more sensitive to both the mood-enhancing effects and the psychosis-inducing effects of cannabis compared with controls (Henquet, van Os, Delespaul, a Campo, & Myin-Germeys, 2009). Cannabis specifically increased hallucinations. The results suggested an immediate rewarding effect of cannabis on mood, whereas the effect on hallucinations was subacute. These findings may give some insight into why patients continue to use cannabis, even though it has long-term negative effects (Henquet,

van Os, et al., 2009). No evidence for the self-medication hypothesis was found in either study, because cannabis use was not predicted by previous mood or intensity of psychosis.

Conclusion

These data suggest that important mechanisms underlying psychosis may be found in the dynamic interplay between the environment and the person. The longitudinal character of the ESM data and the assessment of both experiences and environmental features allowed for the investigation of subtle person–environment interplays that may be essential mechanisms underlying psychosis yet have not been previously identified.

Psychological Models

The use of ESM in studying psychological processes in psychosis is still in its early stages. Most research on psychological models is based on cross-sectional assessments, whereas psychological models generally assume dynamic interactions between different constructs. ESM, with its longitudinal character, enables the study of dynamic patterns over time and seems therefore a promising method to study and develop psychological models.

Paranoia

Paranoia or persecutory delusions are common in psychotic spectrum disorders and refer to the experience in which an individual feels that he or she is the victim of some kind of malevolent plot. A recent psychological model states that persecutory delusions serve as a defense against negative thoughts and feelings about the self and thereby enhance self-esteem level (Bentall, Corcoran, Howard, Blackwood, & Kinderman, 2001). Studies on the relationship between paranoia and self-esteem level, however, revealed inconsistent results. A recent ESM study examined the temporal relationship between paranoid experiences and not only self-esteem level but also self-esteem variability in individuals with varying degrees of psychotic liability (Thewissen et al., 2008). Paranoia was measured using four items: “I feel that others dislike me,” “I feel that others might hurt me,” “I feel suspicious,” and “I feel safe.” Self-esteem level was also measured after every prompt and was defined using four items: “I am a failure,” “I am ashamed of myself,” “I am a good person,” and “I like myself.” Higher psychosis liability was found to be associated with lower self-esteem levels and higher self-esteem variability. Moreover, decreases in self-esteem were associated with increased paranoia. This ESM study thus offered a plausible explanation of the inconsistent results on the relationship between self-esteem level and paranoia, indicating that it is not self-esteem level per se but fluctuations in self-esteem level that may induce paranoia (Thewissen et al., 2008).

Coping

Coping is related to how people deal with the problems in their daily life (Lazarus & DeLongis, 1983). However, relating the psychological concept of coping to real-life behavior is complicated (Marco, Neale, Schwartz, Shiffman, & Stone, 1999; Schwartz, Neale, Marco, Shiffman, & Stone, 1999). One study used ESM to investigate coping mechanisms in psychosis. This study compared symptomatic coping, defined as going along with the content of psychotic symptoms

(e.g., carrying out hallucinatory commands or carrying a weapon to defend oneself against imagined persecutors), and nonsymptomatic forms of coping (e.g., suppression or socialization). Coping in daily life was assessed using three items in the ESM booklets (rated on 7-point Likert-type scales): "I chose this social situation to reduce my stress," "I chose this activity to reduce my stress," and "I chose these substances to reduce my stress." Additionally, coping strategies were measured using a structured interview. Interview-based symptomatic coping was negatively associated with ESM measures of coping in daily life, whereas nonsymptomatic coping was positively associated with ESM coping measures. Furthermore, patients with high levels of nonsymptomatic coping reported more distress associated with their psychotic symptoms, suggesting that effective coping is associated with the tendency to develop conscious appraisals of distress associated with psychotic symptoms (Lardinois et al., 2007).

Future Directions and Conclusions

So far in this article, we have demonstrated the added value of ESM research for the study of the phenomenology, etiology, and psychological models of psychosis. However, ESM may also fuel studies in new research areas.

Gene × Environment (G × E) Interactions

One new and expanding area is the study of G × E interactions, which have been suggested to play an important role in the etiology, course, and outcome of psychosis (Henquet et al., 2008; Henquet, Rosa, et al., 2009; Lataster et al., 2009; Simons et al., 2009; van Winkel, Isusi, et al., 2008). According to the G × E interaction theory, susceptibility genes amplify the risk for an individual to react with psychosis in response to environmental pathogens. Moffitt, Caspi, and Rutter (2005) suggested a prospective collection of cumulative, repeated measures of proximal rather than distal environmental risk factors to optimize the environmental risk measurement in G × E research. ESM technology may thus be well placed to implement this methodological improvement and contribute to the study of G × E interactions in psychosis.

So far, only three ESM studies on G × E interactions in psychosis have been published. The COMT Val ^{158}Met genotype is hypothesized to play a role in psychosis, albeit a complicated one. Van Winkel, Henquet, et al. (2008) investigated whether COMT Val ^{158}Met moderated the emotional and psychotic reactivity to stress in a sample of patients with psychosis and controls. Patients with one form of this genotype (Met/Met) showed the largest increase in psychotic experiences and negative affect in reaction to daily stressors, thereby providing evidence for a G × E interaction between the COMT Val ^{158}Met genotype and stressful events in the flow of daily life in patients (van Winkel, Henquet, et al., 2008). A second G × E interaction study on the moderating effect of the COMT Val ^{158}Met and BDNF Val ^{66}Met genotype on the relationship between stress and psychosis in a general population sample found opposite results for the COMT Val ^{158}Met genotype. In this study, COMT Val/Val carriers displayed more feelings of paranoia in response to event-related stress compared with COMT Met/Met carriers. Furthermore, BDNF Met carriers had more paranoid reactions to social stress than did BDNF Val/Val carriers (Simons et al., 2009). A final study in patients with psychosis demonstrated that the COMT Val carriers, but not subjects with the Met/Met genotype, reported an increase in the intensity of hallucinations in response to cannabis use (Henquet, Rosa, et al., 2009). These initial studies show the feasibility of ESM data for the study of G × E interactions

by examining the immediate effect of risk exposure conditional on genetic vulnerability for psychosis.

Treatment

ESM may also be very useful in clinical psychopharmacology and treatment studies, because ESM might provide more accurate information with better ecological validity compared with clinician reports, self-report questionnaires, and laboratory designs (Moskowitz & Young, 2006a). Furthermore, it has been suggested that the collection of many data points reduces random error variance and increases sensitivity to detect change. In addition, daily diary methods may have added value for the assessment of medical adherence (McQuaid, 2008; Quittner, Modi, Lemanek, Ievers-Landis, & Rapoff, 2008). Despite these clear advantages, there are no studies published yet using ESM in treatment studies of psychosis.However, to our knowledge, at least two studies are underway that are investigating improvements in symptoms and social functioning following both cognitive and psychopharmaceutical treatments.

Conclusion

In conclusion, in this article, we demonstrated the feasibility and validity of ESM research in the study of psychosis. Furthermore, the review has shown the added value of ESM findings for a better understanding of the phenomenology, underlying mechanisms, and treatment of psychosis. Variability over time and the dynamic interplay with the environment were found to be essential features of the positive symptoms of psychosis, whereas behavioral patterns as well as self-reported affect in daily life reality might be essential when studying negative symptomatology.
ESM has also been shown to contribute to a better understanding of the interplay between psychotic experiences and environmental features, such as stress or cannabis exposure, particularly because most of these interaction patterns are subtle and not always consciously appraised. The study of symptomatic variability may fuel new research into psychological models and treatment of psychosis.

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